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STATISTICAL CRITERIA FOR THE EXTINGUISHING OF THE FOEHN IN WEST--ETC(U)
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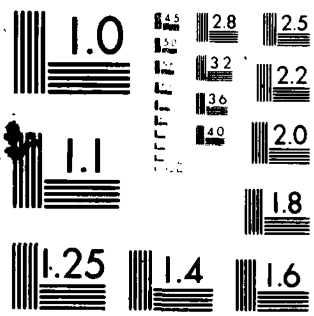

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FOREIGN TECHNOLOGY DIVISION

STATISTICAL CRITERIA FOR THE EXTINGUISHING
OF THE FOEHN IN WESTERN AUSTRIA

by

Georg Skoda

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STATISTICAL CRITERIA FOR THE EXTINGUISHING OF THE FOEHN IN WESTERN AUSTRIA.

Georg Skoda (Vienna).

(1 illustration).

Summary.

The approaches of cold fronts in the western part of Austria during periods of a southwesterly air-stream are examined. From air pressure observations in the afternoon at three stations, correlations result which make it possible to draw conclusions about the probability of precipitation the next morning.

Proceeding from the observation .. about twelve hours before the intrusion of a cold front into the western federal states a characteristic air pressure distribution frequently sets in; that in

particular the air pressure of Bregenz, reduced to sea level, begins to rise above the analogous pressure of Salzburg precisely when the disturbance from the west or northwest crosses the Swiss Jura lets us assume that by observing the air pressure, reduced to sea level, of a few preferred points we can predict the extinguishing of the foehn currents, which have a favorable effect on the weather, in western Austria.

We evaluated the Austrian synoptic weather reports of the years 1966 and 1967, for which the following demands were made:

a) in the end period the mountain stations show a southerly (or beginning southerly) stream component.

b) east of the zero degree meridian over western or northern Central Europe (up to western Switzerland or the southern Rhineland) there lies a cold front or high-altitude cold front. At a level of 850 mb a temperature drop of at least 5°C is required.

The eastern displacement and the weather effect of the fronts depends to a great degree on

c) formation of a "secondary wave" (trough intensification) over France.

All observation dates which satisfy a) and b) are assigned to c) or "not c)" and brought into relation to the pressure differences of the west Austrian principal cities. The question is whether from the pressure differences at 0600, 0900, 1200, and 1500 we can establish a precipitation forecast for the following day at 0600.

Continuous entries are made in diagrams, one of which is shown in Fig. 1. (+ demand c) satisfied, ⊙ demand c) not satisfied). The distribution of precipitation is divided into four stages:

1) precipitation at none of the stations of western Austria at the 0600 deadline of the following day,

2) precipitation at fewer than one third of all stations "),

3) precipitation at one to two thirds of all stations "),

4. precipitation at more than two thirds of all stations Vorarlberg, Tirol, and Salzburg at 0600 the following day.

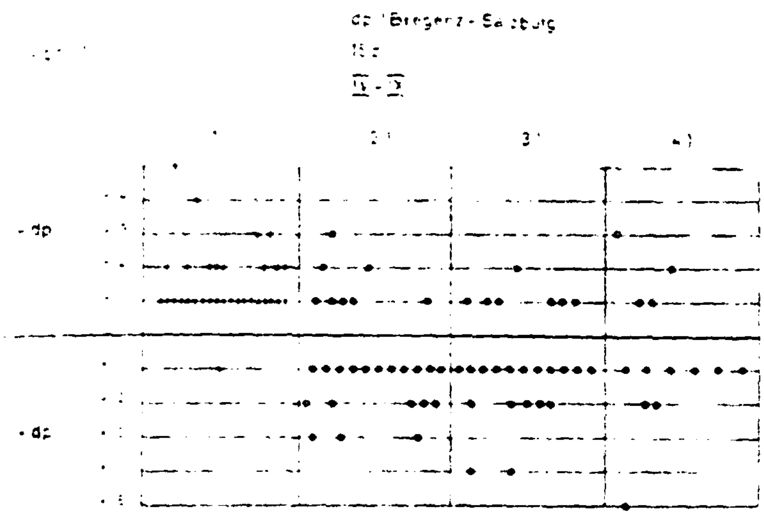

Fig. 1. Example of one of the diagrams used to obtain rules for forecasting. The difference in the air pressures, reduced to sea level, of Bregenz and Salzburg in mb at 1500 is assigned to the type of weather in western Austria on the following day at 0600: 1. precipitation at no stations, 2. precipitation at fewer than one third of the stations, 3. at one to two thirds, 4. at more than two thirds. A differentiation is also made between the cases in which a trough intensification over France delays the advancement of the cold front which ends the foehn period (crosses) and the cases in which this does not occur (circles).

All air pressure differences are rounded up or down to whole mb whereby the cases with a difference of 0 were eliminated from the investigation since these would veil the results. After excluding the periods with too little observation density the following number of cases remained for statistical processing:

	1) um 06 z	09 z	12 z	15 z
Bregenz — Salzburg				
2) in den Wintermonaten (I—III, X—XII)	84	91	81	78
3) in den Sommermonaten (IV—IX)	115	97	100	97
Bregenz — Innsbruck				
2) in den Wintermonaten (I—III, X—XII)	82	90	77	76
3) in den Sommermonaten (IV—IX)	123	101	100	105

KEY: 1. at; 2. in the winter months; 3. in the summer months.

The delay of cold fronts in the west European region in case c) (see Fig. 1, cases +) and the attendant lack of precipitation was to have been expected, but is not equally strongly pronounced for all times.

Since the areas to the north of the main ridge of the Alps simultaneously react with sensitivity to the ground pressure distribution even a weak northern ground wind component can lead to foehn pauses, increased cloudiness and isolated precipitation, the attempt is made to relate the differences of the pressure values, reduced to sea level, of B-S (Bregenz minus Salzburg) and B-I

(Bregenz minus Innsbruck) with the demand c) or "not c)". Simultaneously the groups 1) (= no precipitation) and groups 2), 3), and 4) (as cases of precipitation) are sorted. The results are presented below in tabular form.

1) Ausgangslage Termin 3)	4) Jahreshälfte	5) Druckdifferenz B—S	6) Trog-Verschärfung	7) Zahl der Fälle	8) Prozent-Anteil	2) Folgewetter (%) 9) Niederschlag	10) Kein Niederschlag
[illegible]	11) W:	—	-	24	95	40	60
		-	-	1	5	0	100
		—	.	42	72	95	5
		-	.	17	28	98	[illegible]
	12) So	—	—	29	75	22	78
		-	—	9	25	10	90
		-	.	46	[illegible]	95	5
		-	.	31	[illegible]	100	0
[illegible]	W:	-		20	[illegible]	45	55
				[illegible]	[illegible]	5	95
		—	.	49	75	88	12
			.	17	25	97	3
	So	-	-	20	70	10	90
		-	—	9	30	12	88
		—	.	34	50	92	8
		-	.	34	50	93	7
[illegible]	W:	—	-	21	78	45	55
		-	—	6	22	10	90
		—	.	19	35	88	12
		-	:	35	65	93	7
	So	—	-	17	50	0	100
		-	—	17	50	0	100
		—	.	10	15	92	8
		-	.	56	85	100	0
[illegible]	W:	—	-	17	65	0	100
		-	-	9	35	0	100
		—	.	21	40	100	0
		-	:	31	60	100	0
	So	—	—	31	98	0	100
		—	+	1	2	0	100
		—	:	19	30	100	0
		-	:	46	70	100	0

Table 1. Probability of precipitation (°/₀) at 0600 the following day in cases of a southwesterly air current over western Austria on the starting day taking into account the sign of the difference of

pressures, reduced to sea level, of Bregenz (B) and Salzburg (S) and the trough intensification over France (+ = yes, ⊙ = no, as in Fig. 1) separated according to winter and summer and according to the initial times 0600, 0900, 1200, and 1500. KEY: 1. initial situation; 2. subsequent weather (•/,); 3. time; 4. half of the year; 5. pressure difference; 6. trough intensification; 7. number of cases; 8. portion in percent; 9. precipitation; 10. no precipitation; 11. winter; 12. summer.

To Table 1 (pressure difference Bregenz-Salzburg):

The times 0600 and 0900, both summer and winter in the majority of cases, show the thermally caused higher pressure of Salzburg. This does not allow anything to be said about the approach of cold fronts. At 1200 and 1500 it is different: here the connection between higher air pressure in Bregenz (compared to Salzburg) and the increasing probability of precipitation on the following day is clear. The correlations are strongest in the summer half of the year at 1500.

…sgangslage 1) Termin 3)	4) Jahreshälfte	5) Druckdifferenz B—I	6) Trog-Verschärfung	7) Zahl der Fälle	8) Prozent-Anteil	2) Folgewetter 9) Niederschlag	10) Kein Niederschlag
[illegible]	11) Wi	—	-	24	100	8	92
		-		0	0		
		—	·	56	97	5	95
		-	·	2	3	99	1
	12) So	—		39	100	6	94
		·	-	0	0		
		—	·	72	85	98	2
		-	·	12	15	100	0
[illegible]	Wi	—	—	26	100	35	65
			-	0	0		
		—	·	61	95	90	10
		-	·	3	5	98	2
	So	—	-	18	60	5	95
		-	—	12	40	1	99
		—	·	32	45	98	2
		-	·	39	55	98	2
12 z	Wi	—	-	15	60	40	60
		+	—	10	40	10	90
		—	·	13	25	99	1
		-	·	39	75	91	9
	So	—	-	0	0		
		-	—	32	100	5	95
		—	·	12	18	98	2
		-	·	56	82	100	0
15 z	Wi	—	-	6	23	50	50
		-	—	20	77	40	60
		—	·	15	30	95	5
		+	·	35	70	90	10
	So	—	-	5	13	0	100
		+	—	33	87	0	100
		—		6	9	100	0
		+	·	61	91	100	0
Erweiterungsfälle: 13)							
14) a) Druckwerte von Innsbruck um 1 mb erhöht							
12 z	So	—	-	18	55	0	100
		-	+	14	45	10	90
		—	·	17	25	99	1
		-	·	51	75	100	0
15 z	So	—	-	25	66	0	100
		+	—	13	34	0	100
		—	·	30	45	100	0
		+	·	37	55	100	0
15) b) Druckwerte von Innsbruck um 2 mb erhöht							
15 z	So	—	+	30	78	0	100
		+	+	8	22	0	100
		—	·	47	70	100	0
		-	·	20	30	100	0

Table 2. Analog to Table 1 for the pressure differences Bregenz (B) minus Innsbruck (I), supplemented by cases with 1 or 2 mb

corrected pressure values of Innsbruck. KEY: 1. initial situation; 2. subsequent weather (°/₀); 3. time; 4. half of the year; 5. pressure difference; 6. trough intensification; 7. number of cases; 8. portion in percent; 9. precipitation; 10. no precipitation; 11. winter; 12. summer; 13. supplementary cases; 14. pressure values of Innsbruck raised by ... mb.

To Table 2 (pressure difference Bregenz-Innsbruck):

Here the distribution is more complicated: the winter times of 0600 and 0900 are again unusable. In the summer on the other hand, the time 0900 has a good correlation - the higher air pressure of valley locations in the morning hours is reduced more quickly in Innsbruck than in Salzburg!

While in the winter half of the year the 1200 time shows favorable results, unexpectedly in the same season at 1500 there is no suitable result. The frequently observed fog in the area of Bregenz in the afternoon hours (temperature decline, pressure rise!) independently of the approach of a cold front could be one explanation.

At first glance the summer data for 1200 and 1500 seemslikewise

unusable. The overwhelmingly larger number of pressure excesses in Bregenz can be explained on one hand by (cool) Lake Constance and by the overheated valley bottom of Innsbruck on the other. However, since we are not talking about a "change of the weather" between the times, a correction of +- 1 mb (or +- 2 mb) can be made to the pressure values of Innsbruck. It then turns out that the times 1200 and 1500 likewise fit into the general scheme. Errors, arising for the most part through the reduction of the air pressure to sea level, can therefore be given on summer afternoons with +1 to +2 mb.

An analogous procedure for the morning values of Innsbruck breaks down. The reduction error, simulated by the nightly radiation compared to Bregenz can be determined for winter mornings with about -2 mb and for summer mornings with about -1 mb, but because of the regrouping of the data no correlation can be drawn between the demand c) or "not c)" and the probability of precipitation. (This is not surprising because of the large time interval).

Rules for Forecasting:

From Tables 1 and 2 as well as from the study of the figures (like Fig. 1) the following relationships can be given for evaluating the probability of precipitation (extinguishing of the foehn) for the morning of the following day, where B, I, and S are the pressure

values, reduced to sea level, of Bregenz, Innsbruck, and Salzburg.

1) Termin	2) Jahreshälfte	3) Druckdifferenz	4) Vorzeichen	5) Wetter am Folgetag (6 z)
09 z	Sommer 6)	B minus I 7)	+	8) Niederschläge
			—	10) keine N.
		9) falls Diff. =	0	keine N.
12 z	Winter	2 B — I — S	+	8) Niederschläge
			—	10) keine N.
		falls Diff. = B minus S	0, dann 11) +	8) Niederschläge
			—	10) keine N.
	Sommer	2 B — (I+1) — S	+	8) Niederschläge
			—	10) keine N.
		9) falls Diff. = B minus S	0, dann 11) —	8) Niederschläge
			—	10) keine N.
[illegible]	Winter	[illegible] 7)		8) Niederschläge
			—	10) keine N.
	Sommer	2 B [illegible]	[illegible]	8) Niederschläge
			—	10) keine N.
		9) falls Diff. [illegible]	[illegible] 11)	8) Niederschläge
			—	10) keine N.

KEY: 1. time; 2. half of year; 3. pressure difference; 4. sign; 5. weather on the following day (0600); 6. summer; 7. minus; 8. precipitation; 9. in case the difference; 10. no precipitation; 11. then.

During application in practice one should bear in mind that the relationships are all the more significant the larger the deviation from the zero value. The case of B-S=0 shows a too weak predominance

of precipitation-free days on the following day so that it is not included in the scheme.

The rules are most successful in the summer months during the approach of high-altitude troughs (with attendant cold fronts) with a shift of less than 10 degrees longitude per 24 hours. Most "failures" occur during zonal high-altitude air-streams and extremely quickly moving ground pressure waves.